INTEGRATED AQUATIC VEGETATION MANAGEMENT PLAN

Entiat Park Columbia River Eurasian Watermilfoil Project
Chelan County, Washington

Prepared by

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Project Overview

This Integrated Aquatic Vegetation Management Plan (IAVMP) was prepared to analyze and propose solutions for the widespread invasive aquatic plants that dominate the Columbia River near the city of Entiat, WA. The project area is located in Chelan County approximately 15 miles north of Wenatchee, WA on the west shore of the Columbia River in the Rocky Reach Dam pool (FIGURE 1**).** The Rocky Reach Dam is a Chelan County Public Utility District (PUD) dam. Following the construction of the dam in 1956, the city of Entiat and Washington State Highway 97 were moved to the west. The project area covers the old city foundations and highway that were submerged by the new dam pool. Aquatic plant mapping conducted in 1999 by the PUD for Rocky Reach Project No. 2145 (Public Utility District No. 1 Chelan County, 1999) showed Eurasian watermilfoil (*Myriophyllum spicatum*) accounted for 50 – 90% of biomass of samples collected.

There is a limited level of control of invasive aquatic plants by the PUD in the form of harvesting the top five feet of plant biomass one or two times per growing season. Regular boat traffic in some areas is limited by uncontrolled plant growth. However, no comprehensive invasive plant control program has been developed or implemented. The Chelan County Noxious Weed Board initiated the organization of the Memorandum of Understanding Concerning the International Control of Invasive Aquatic Vegetation for the Upper Columbia River System Cooperative Weed Management Area (CWMA). Participants in the CWMA are looking at Eurasian watermilfoil in their jurisdictions, and some are implementing control projects. Information that is gained by planning and implementing this control project at the Entiat City Park shoreline should be applicable to other projects along the Upper Columbia River system.

The first step of the planning process was to apply for a planning grant from the Washington State Department of Ecology. A planning team was assembled following the acquisition of the grant funding.

The planning process was composed of the following steps:

1. Establishment of a planning team composed of members of aquatic plant and lake management technical experts and public agencies involved in the management of the Columbia River and its shoreline.
2. Development of a Problem Statement that defines the primary aquatic plant management issues facing the upper Columbia River.
3. Development of Goals and Objectives to address the issues identified in the Problem Statement.
4. Collection of information on existing and previous conditions in the Columbia River near Entiat. This includes information on the distribution of native and invasive aquatic plants, uses or management actions that affect aquatic plant populations and beneficial uses of the water body.
5. Analysis of available aquatic plant control options and assessment of each option's ability to

meet the Goals and Objectives.

6. Development of a range of aquatic plant Control Scenarios to compare effectiveness, costs and timelines.
7. Selection of a Preferred Control Scenario by the Planning Team.
8. Dissemination of information on the IAVMP development process and Preferred Control Scenario to the public for discussion.
9. Finalization of the Preferred Control Scenario and preparation the IAVMP documentation (as embodied in this report).
10. Continuation of the planning team as advisors to the implementation of the control plan.

Each of these steps is described in more detail in the sections that follow. The preparation of this IAVMP is the first step in applying for aquatic plant control funding and implementing the control recommendations developed during the planning process.

Planning Team

A planning team was established to provide professional input and guidance for the preparation of this IAVMP. This group was drawn from aquatic plant and lake management technical experts and county, state, and federal public agencies involved in the management of the Columbia River and shore.

The Planning Team members are:

- Mike Mackey — Chelan County Noxious Weed Board
- Julie Campbell — US Fish and Wildlife Service
- Waikele Frantz — Chelan County PUD (lead contact)
- Kurt Getsinger — US Army Corps of Engineers Research and Development Center (USACERDC)
- Gina Hoff — US Bureau of Reclamation
- Steve Lewis — US Fish and Wildlife Service
- Terry McNabb — AquaTechnex
- Jenifer Parsons — Washington State Department of Ecology
- Lizbeth Seebacher — Washington State Department of Ecology (lead contact)

The Planning Team met on two occasions to:

1. Determine tasks for the planning process to be assigned to each specialty
2. Develop a problem statement and detailed IAVMP goals and objectives
3. Review treatment options and determine a preferred treatment scenario

These steps are discussed in more detail below. The Planning Team then finished the plan. This IAVMP report represents that finished plan.

Problem Statement

Eurasian watermilfoil (*Myriophyllum spicatum)* is an exotic invasive aquatic plant found in the Columbia River and its tributaries. Invasive aquatic vegetation, including Eurasian watermilfoil, presents an imminent threat to the native fish and plant species and water quality in the river basin, including those populations listed as species of special concern to the State of Washington and the Federal Government of the United States, and certain Canadian partners. There is a common interest in integrated water resources management (IWRM) and aquatic noxious weed control. Regional agencies, tribes and governments have independent missions with technical activities of mutual interest, and independent missions to control invasive aquatic vegetation, including Eurasian watermilfoil. Uncontrolled invasive aquatic vegetation populations within one jurisdictional area greatly affect the ability of land managers to manage natural resources and control such invasive aquatic vegetation on lands/waters both within their jurisdictional area and among and between neighboring jurisdictions. Prevention and control of invasive aquatic vegetation, including Eurasian watermilfoil, in the Upper Columbia River system requires the coordinated effort of all parties.

The outcome of this pilot project will determine for the agencies and governments involved whether this treatment is economically feasible and environmentally sound and can be expanded throughout the Columbia River system.

Aquatic Vegetation Management Goals and Objectives

The **goal** of the Columbia River Integrated Aquatic Vegetation Management Plan is to reduce invasive aquatic vegetation coverage within the pilot project area that supports the highest levels of the activities currently impaired, while protecting native aquatic wildlife.
To achieve this goal, the following **objectives** will be pursued:

1. Control invasive aquatic vegetation in the Columbia River from the confluence of the Entiat River to a point approximately 2 miles north.
2. Control invasive aquatic vegetation in areas that will benefit juvenile salmonid migration.
3. Control invasive aquatic vegetation in a manner that does not negatively affect native salmonids.

Evaluation of Water Body and Aquatic Vegetation Conditions

Aqua Technex, LLC along with USACERDC provided information on the following aspects of the project:

1. History of Eurasian watermilfoil infestation in the Columbia River
2. Mapping of aquatic plant population
3. Characterization of water exchange
4. Review of herbicides that are selective and systemic for Eurasian watermilfoil
5. Treatment areas and water volumes present in project area
6. Development of budget for treatment demonstration

7. Development of protocols for treatment
8. Evaluation of control achieved by selected protocol
9. Recommendations for future efforts

The results of the analysis are presented in the report Columbia River Eurasian Milfoil Mapping Project by Aqua Technex, LLC. **(**SEE APPENDIX A**).**

Physical Characteristics

The project area is located within the pool between two dams, Rocky Reach and Wells Dam. Water flow fluctuates daily because of power generation needs. Water depth in the cove area of the project averages 6 to 8 feet. The average depth in the narrow shoreline bands is closer to 11 to 13 feet. The entire targeted area for treatment is 69 acres. The river bottom in the project area consists of a gentle sloped beach area that gets exposed to freezing temperatures in the winter draw down period. There are also areas of concrete and asphalt that were submerged after the dams were built.

Geology and Hydrology

The watershed of the Lake Entiat Pool of the Columbia River lies east of the Cascade Mountains and west of the Rocky Mountains, consisting of parts of Washington, Idaho, Montana, and British Columbia. The watershed encompasses about 90,000 square miles. The surface geology along the Columbia River is typical glacial till and volcanic basalt over metamorphic bedrock formed millions of years ago through compaction of sedimentary material.

The regulated flow of the Columbia River at the Rocky Reach Dam varies between 40,000 cubic feet per second (cfs) and 220,000 cfs. The Rocky Reach pool, known as Lake Entiat, extends upriver 43 miles and has a surface area of 98,000 acres. The pool contains 35,000 acre feet of usable storage with a 4 foot drawdown. The average annual minimum temperature of 37 degrees Fahrenheit occurs in February. The average annual maximum temperature of 65 degrees Fahrenheit usually occurs in August and September.

Wetlands

Other than the immediate shoreline of the project area there are no designated wetlands in the project area.

Land Use

The land surrounding the project area on the Columbia River is used for recreation with a city park, swimming beach, overnight camping facilities for tent and RV, and a boat launch.

Water Quality

Due to the size of the Rocky Reach pool and the Columbia River and the sustained river current, water quality in the project area is largely determined by conditions in the Columbia River watershed. There

are isolated portions of the Rocky Reach pool that may experience seasonal degraded water quality conditions due to inputs from the tributaries and due to dense aquatic vegetation impeding water circulation patterns in shallow pool areas. However, overall, water quality conditions in the project area are similar to those found in the Columbia River.

Currently the water in the Columbia River is considered high quality for most parameters important to fish, wildlife and human uses (dissolved oxygen, temperature, pH, conductivity, metals and nutrients such as phosphorus) (Public Utility District No. 1 Chelan County, 2001).

Water Rights

The City of Entiat was contacted to provide information regarding the water rights for diversions out of the Columbia River in the project area. At the beginning of the planning process we had been informed that the City of Entiat domestic water and Entiat Irrigation District had water take outs on the Columbia River. We have since learned that there are two wells, each 40 feet from the river and 140 feet deep that are used for domestic water and irrigation. Water is pumped from the wells, and not directly from the Columbia River. The report submitted by Aqua Technex, LLC reflects this misunderstanding in that it discusses options for herbicide treatment that takes into account the existence of 2 water take outs on the river in the treatment area. A letter from the mayor of the City of Entiat is attached (see Appendix D) that corrects the information on the water usage near the project area.

Fish and Wildlife Community

Fish Usage

The Columbia River project area near the confluence of the Entiat River serves as a migration corridor for upstream and downstream migration to and from spawning areas in tributaries, downstream migration and emigration for juvenile fish, and rearing, feeding and overwintering for juvenile and adult fish of some species. The fish species using the area in different seasons include Upper Columbia River spring run Chinook salmon (*Oncorhynchus tshawytscha*), bull trout (*Salvelinus confluentus*), Upper Columbia steelhead (*Oncorhynchus mykiss*) and Pacific lamprey (*Lampetra tridentate*) (**SeeTable 1**).

Table 1. Fish migration times in the Columbia River project area.

Species	**Migration window**
Chinook Salmon spring run	April to July
Chinook Salmon summer/fall	Late June to mid November
Chinook Ocean type juveniles	June to July
Steelhead	Late summer to early fall
Bull trout	Mid to late August
Pacific lamprey	Between March and July (Limited information)

Status of Listed/Sensitive Fish Species in the Mid-Columbia River in the Vicinity of the Entiat River

The Upper Columbia River Spring-run Chinook salmon (*Oncorhynchus tshawytscha)* is listed as endangered under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1536(a)(2)). The Entiat River is included in the Upper Columbia River evolutionarily significant unit (ESU) for naturally-spawned Spring-run Chinook, and is one of three major tributary sub-basins with existing runs (National Marine Fisheries Service, 2011). In general, this population of Spring-run Chinook salmon begins migrating from the ocean in early spring and the fish enter the tributaries of the Upper Columbia River (including the Entiat River) between April and July with peak run in mid-May. The fish spawn in late summer (peak spawning is mid-late August) and then die in the tributaries. Juvenile Chinook salmon typically emigrate out to salt water in the spring of their second year (National Marine Fisheries Service, 2011) .

Summer and fall Chinook (ocean-type) salmon use the proposed project area as a corridor during their upstream and downstream migrations. Ninety percent of adult summer and fall Chinook pass upstream through Rocky Reach Dam, located south of the Entiat River tributary of the mid-Columbia River, on their way to spawning grounds from the end of June through the middle of November (Fish Passage Center, 1995). Summer and fall Chinook spawn in tributaries of the mid-Columbia River including the Entiat River and in the Lake Chelan Hydroelectric Project tailrace (Giorgi, 1992) (Chapman, 1994). They may also spawn in the reservoirs and tailraces of the Wells and Rocky Reach Hydroelectric Project dams.

Ocean-type Chinook juveniles migrate downstream in late summer as sub-yearlings. Juvenile migration timing at the Project is similar to juvenile passage at the downstream Rock Island Hydroelectric Project, where 90 percent of juvenile passage occurs during June and July. Juvenile ocean-type Chinook salmon passing the Project originate from both hatchery and natural production. McGee (McGee, 1984) reported a size range of 41 to 175 mm (average of 114.5 mm) for juvenile ocean-type Chinook salmon passing Wells Hydroelectric Project. The size of naturally produced ocean-type Chinook juveniles at the Rock Island Hydroelectric Project ranges from 30 mm to 50 mm in late May/early June, and increases to 80 mm to 120 mm by late July (Peven & Duree, 1990). Sizes at the Rocky Reach Dam are expected to be similar, although very small fish observed in May and June at the Rock Island Hydroelectric Project are probably from the Wenatchee River since they are rarely seen at Rocky Reach Dam. Unlike stream-type Chinook salmon, juvenile ocean-type Chinook are likely to spend time rearing in the Rocky Reach Reservoir.

The Upper Columbia River population of steelhead *(Oncorhynchus mykiss)* is designated as a Distinct Population Segment (DPS) and is listed as threatened under the ESA. The Wenatchee and Entiat populations have low natural productivity and are considered moderate to high risk for extinction over a 100-year timeframe (National Oceanic and Atmospheric Administration, 2011). Upper Columbia River steelhead return to their natal tributaries in late summer or early fall. While many move into the tributaries fairly quickly, some remain in reservoirs of the main-stem Columbia River throughout winter,

then migrate into natal tributaries in the spring (National Oceanic and Atmospheric Administration, 2011). Spawning occurs in late-spring of the year following entry, and juveniles may spend from one to seven years in freshwater before they migrate to salt water during spring. Steelhead are an iteroparous species (may spawn more than once during a lifetime) and post-spawn kelts migrate back to the ocean following spawning.

The U. S. Fish and Wildlife Service (USFWS) listed bull trout (*Salvelinus confluentus)* within the Columbia River Basin District Population Segment as threatened under the Endangered Species Act (ESA) on June 10, 1998. On November 1, 1999 bull trout were listed throughout the coterminous United States as threatened under the ESA. Declining bull trout populations are thought to be the result of habitat degradation and fragmentation, blockage of migratory routes, reduced water quality, and introduction of nonnative species.

The mid-Columbia River basin has been designated the Upper Columbia River Recovery Unit (United States Fish and Wildlife Service, 2002) (U.S. Fish and Wildlife Service, 2004) and includes the Wenatchee, Entiat, and Methow River watersheds as core population areas. Bull trout in core areas with less than five local populations may be at increased risk of local extinction when dealing with deterministic and stochastic events, a result of the inability to spread risk among a larger collection of local populations (Rieman & McIntyre, 1993). Bull trout in the Entiat River Core Area are considered to be especially sensitive to local extinctions because only two local populations of fluvial bull trout are thought to exist in the Entiat River watershed: the Mad River population and the upper Entiat River population (United States Fish and Wildlife Service, 2002) (U.S. Fish and Wildlife Service, 2004).

Entiat River and its tributaries have been identified as a Core Area within the Upper Columbia Recovery Unit (U.S. Fish and Wildlife Service, 2005). Two sub populations of fluvial bull trout have been identified in the Entiat River and Mad River (tributary to the Entiat River). In general, bull trout migrate up the Entiat River and spawn in mid-late August, then quickly migrate back down to the main-stem Columbia River, where they feed and overwinter in main-stem (including the Entiat River Delta area). Recent data (BioAnalysts, Inc, 2004) on post-spawn bull trout indicate that a limited number of bull trout may be present during project implementation; however, the risk of effects to these individuals is likely to be low.

Pacific lamprey (*Lampetra tridentata*) are present in most tributaries of the mid-Columbia River and in the mainstem Columbia River during their migration stages. They have cultural, utilitarian and ecological significance in the basin, because Native Americans have historically harvested them for subsistence, ceremonial and medicinal purposes (Close, Fitzpatrick, & Li, 2002). As an anadromous species, they also play an important role in the food web by contributing marine-derived nutrients to the basin and may act as a predatory buffer for juvenile salmon and steelhead. Little specific information is available on the life history or status of lamprey in the mid-Columbia River watersheds. They are known to occur in the Methow, Wenatchee and Entiat rivers (National Marine Fisheries Service, 2002)

and recently have been captured during juvenile salmon and steelhead trapping operations in the Okanogan River.

Pacific lamprey populations of the Columbia River have generally declined in abundance over the last 40 years according to counts at dams on the lower Columbia and Snake rivers (Close et al. 2002). Starke and Dalen (1995) reported that adult lamprey counts at Bonneville Dam regularly exceeded 100,000 fish in the 1960s and more recently have ranged between 20,000 and 120,000 for the period 2000-2004 (DART - www.cqs.washington.edu/dart/adult.html). Close et al. (Close, et al., 1995) (Close, Fitzpatrick, & Li, 2002) identified several factors that may account for the decline in lamprey counts in the Columbia River Basin. This includes reduction in suitable spawning and rearing habitat from flow regulation and channelization and pollution, reductions of prey in the ocean, and juvenile and adult passage problems at dams.

Other Wildlife

The project area in the Columbia River is utilized by a variety of waterfowl, including ducks, geese, and coots; and predatory birds including great blue herons (*Ardea herodias*), osprey (*Pandion haliaetus*) and bald eagles (*Haliaeetus leucocephalus*). The waterfowl forage for food, rest, and take refuge in the area. Great blue herons and bald eagles prey on fish, rodents, and amphibians from the river and adjacent shore. There are documented osprey nests along the shoreline.

Aquatic Plant Community

To characterize the aquatic plant community that occurs in the project area on the Columbia River previous surveys of aquatic plants in the area were reviewed and a preliminary survey of the area was conducted in September 2011 to establish baseline information on the distribution of species in the study area. The results of the September 2011 survey are shown in **Table 2.**

Table 2. Previous Surveys Aquatic Plant Species List

Scientific name	***Common name***	***Distribution Value****	***Comments***
Ceratophyllum demersum	Coontail; hornwort	*2*	
Chara sp.	muskwort	*2*	
Iris pseudacorus	yellow flag	*2*	
Lythrum salicaria	purple loosestrife	1	
Myriophyllum spicatum	Eurasian watermilfoil	3	dense in some areas, patchy in others
Nitella sp.	stonewort	1	
Phalaris arundinacia	reed canarygrass	2	
Potamogeton crispus	curly leaf pondweed	2	
Potamogeton illinoensis	Illinois pondweed	1	
Potamogeton richardsonii	Richardson's pondweed	3	dense in some areas
Potamogeton sp. (thin leaved)	thin leaved pondweed	3	
Ranunculus aquatilis	water-buttercup	2	
Stuckenia pectinata	sago pondweed	3	
Typha latifolia	common cat-tail	2	

*1 = scarce; in 1 or a few locations
2 = common, with a wide patchy distribution
3 = large patches, codominant with other species
4 = dominant, but other species present
5 = monospecific, dense growth excluding other species

Aqua Technex, LLC was also contracted to assess the density of two invasive aquatic species, Eurasian watermilfoil and curlyleaf pondweed throughout the project area. Samples were rated as sparse, moderate or dense for these two species. The most dominant noxious weed was Eurasian watermilfoil, with 66% of the samples falling into the moderate or dense category. In 4% of the sample locations curly pond weed was the dominant aquatic vegetation. Detailed results of their survey can be found in Appendix A.

Previous Surveys

The aquatic species data from the Final Study Report Rocky Reach Project 2145 PUD Habitat Survey was reviewed (Public Utility District No. 1 Chelan County, 1999). Eurasian watermilfoil was the most abundant species in the surveys conducted of the dam pool. About one third of all the macrophyte bed acreage in the area was vegetated by dense Eurasian watermilfoil growth. Curly pondweed was the third most abundant species in cumulative biomass samples. The two most abundant native species, often found growing as an understory in topped out Eurasian watermilfoil, were coontail (*Ceratophyllum demersum*) and waterweed (*Elodea canadensis*).

Beneficial Uses

The project area is the site of multiple beneficial uses. Its proximity to the Entiat City Park, results in a variety of uses particularly boating, swimming, wildlife observation and recreational fishing.

Watercraft use by visitors is abundant; visitors use the water for fishing, canoeing, kayaking and water skiing. During the summer, access for most activities except fishing becomes restricted due to the dense growth of invasive aquatic vegetation.

This area is also a popular swimming location, with access from the Entiat City Park. During the summer swimming use is restricted by the dense growth of Eurasian watermilfoil, which becomes a life safety hazard.

A variety of salmon as well as walleye, bass, steelhead and trout are taken by anglers from both shore and boats. Fishing activities are dispersed, based on access and target species. Shoreline fishing targets steelhead and is focused near the confluence of the Entiat and Columbia Rivers. Bass, walleye, steelhead and salmon are also fished from boats.

Aquatic Vegetation Management Options

A number of aquatic vegetation management options were considered to address the invasive plant issues facing the project area in the Columbia River. The options considered covered the breadth of techniques in use by aquatic plant managers and lake stewards.

Each option was evaluated for:

- Compatibility with water body characteristics
- Effectiveness on target species
- Ability of the control option to achieve plan objectives

The options considered are summarized in **Table 3.**

Table 3. Summary of Aquatic Plant Control Option Analysis

Aquatic Plant Control Option	*Compatibility with Water Body Characteristics*	*Effectiveness on Target Species*	*Promote for More Detailed Consideration?*
Grass Carp	Not compatible. Use of this fish requires containment to prevent escape. Not feasible at this site.	Marginal. Prefers to consume native species before target species.	No
Bottom Barriers	Very large area to cover, which would be expensive for materials and installation.	Due to the extensive populations of the invasives that will provide fragments (that would root on top of the barrier), This method would require regular removal, cleaning, and resetting every 2 weeks.	No
Watermilfoil Weevil	Questionable due to the availability of large numbers of weevils.	Can be effective if a reproducing population is established or breeding program is developed to supply weevils.	Yes
Diver Dredge	Compatible	Effective, but excessively expensive given the area.	No
Sediment Dredge	Not compatible due to water quality issues, exposure of contaminated sediments, disposal costs, and effects on fish species.	Effective if water depths are increased such that plant growth is reduced.	No
Harvesting	Compatible. Timing restrictions may be applied based on salmon migrations.	Effective, but only short-term control. High equipment and disposal costs.	Yes
Herbicides	Some are compatible, based on timing of use, dosage, and salmon migrations.	Very effective, if correct chemical is properly applied.	Yes

Based on this assessment, harvesting, herbicide use, and watermilfoil weevils were promoted for more detailed consideration and treatment scenario development. This analysis is described in the following section.

Selection of Preferred Submerged Plant Control Plan

Three treatment scenarios were developed and presented to the planning team for consideration. The three strategies for submerged plant control included one that relied only on mechanical control (harvesting), one that used biological control, and one that relied on herbicides. Each is briefly summarized here along with descriptions of their use rationale and a summary of why they were or were

not selected as the preferred plan.

Scenario 1: Mechanical Harvesting

Harvesting is a non-chemical method of removing vegetation from water bodies that is similar to mowing a lawn. There is a range of harvesting equipment sizes and designs, but they all work basically the same way. The harvester cuts aquatic vegetation between 2 and 6 feet below the water surface. A conveyer system piles the cut vegetation which is later offloaded onto shore and taken to a disposal site.

Although harvesting efficiency varies by plant density, generally a harvester can only cut about 3 acres per day. This, in combination with the fact that the vegetation grows back fairly quickly, and therefore an area needs to be cut multiple times each summer, means that it is only reasonable to control smaller areas. The scenarios developed included harvesting only a small area in the swimming and launching areas of the water. It was assumed, based on data from the Chelan County PUD, that approximately 6 acres could be harvested for approximately $4000 each year (this includes other implementation costs) for a cost over a 10-year period of approximately $40,000 to $80,00 depending on how many harvest are done per season.

Harvesting was not selected as the preferred strategy. It was by far the most expensive of the scenarios but more important, it only minimally met the goal of suppressing the vegetation to a population that did not impact beneficial uses. The vegetation would still be problematic for human recreational use for much of the summer and the strategy would not improve fish or wildlife habitat.

Scenario 2: Watermilfoil weevils

A pilot project evaluating the use of milfoil weevils for biological control is being done by Okanogan County Noxious Weed Control Board (OCNWCB) in conjunction with the Chelan County Noxious Weed Board pilot project. The project is being conducted in Lake Osoyoos in Okanogan County. The outcome of the Okanogan County project will determine to what extent weevils could be used for Eurasian watermilfoil control in the Columbia River in the future.

Lake Osoyoos contains a total of 5,723 acres of which 2,046 acres are in the United States. Given that Lake Osoyoos is a main watershed for the Okanogan River which flows downstream to the Columbia, OCNWCB will attempt to involve stakeholders from multiple agencies and jurisdictions including the City of Oroville, Lake Osoyoos landowners on the United States side of the US/Canadian border, Okanogan County Commissioners, Okanogan County Weed Board, and appropriate Chelan County officials.

The Lake Osoyoos project will include efforts to rear weevils locally to prevent problems associated with moving invasive species across state boundaries. Weevils that are reared for biocontrol projects have to be transported on milfoil plants in water. Based on the efforts of the OCNWCB to develop a method of rearing milfoil weevils in an economically feasible way, CCNWCB would consider using weevils as a follow up control method in the project area.

Scenario 3: Herbicide Selection

The planning team discussed the use of several chemicals to be used for control of Eurasian

watermilfoil. (See page 14 Herbicide Toxicity Evaluation). Triclopyr was determined to be the chemical that is the most compatible with the threatened and endangered species of fish that may be in the area during and following application of herbicide.

There are a number of systemic herbicides available that are selective for Eurasian watermilfoil. A number of studies have shown that granular herbicide delivery systems provide superior contact exposure times in moving water situations in comparison to liquid formulations that are much more subject to dilution and movement with the current.

Renovate OTF is a granular formulation of Triclopyr herbicide on a controlled release pellet. This product has excellent activity against Eurasian watermilfoil. It is also systemic and selective for Eurasian watermilfoil. Cost per acre is a function of the application rate and water depth. Currently the cost for Renovate OTF is $143 per 40 pound bag of granular product.

This scenario was selected as the preferred plan by the planning team. It achieved a high level of control or suppression of the plants and therefore met the key management goals of providing for beneficial uses by people and wildlife. It was the least expensive of the scenarios and overall required the least herbicide use. Labeling information and summary information on environmental concerns and toxicity for triclopyr can be found in the section *Herbicide Toxicity Evaluation* and in Appendix B.

Recommended Aquatic Vegetation Control Plan

Submerged aquatic plant control with triclopyr (Treatment Scenario 3) was selected as the preferred treatment plan. The criteria for this decision and plan implementation details are provided below.

The primary goal of the Submerged Plant Control plan is the suppression of Eurasian watermilfoil. Suppression in this case means limiting plant growth and density to a population that does not impede recreation or present a swimming safety risk. In addition to improving the beneficial uses for people, suppressing these invasive noxious weeds will also help provide a more diverse habitat structure for fish and other aquatic life. The total project area that will be controlled encompasses approximately 69 acres (SEE MAP IN APPENDIX A, CHELAN COUNTY NOXIOUS WEED BOARD EURASIAN MILFOIL MANAGEMENT PROJECT – EXTENT OF EURASIAN MILFOIL BEDS IN PROJECT AREA).

Other activities associated with implementation of this plan include the monitoring of the outcome of the pilot project.

Use of a granular formulation of triclopyr is the key part of the submerged plant control strategy. The general application strategy for triclopyr as applied to Eurasian watermilfoil populations is to maintain an effective concentration of the herbicide in the water column. The rates and application method will be determined based on the outcome of water flow tests that will be conducted just prior to treatment. Unlike a lake, this body of water has continuous and fluctuating flow, therefore, flow and exposure time studies were recommended by the planning team to be completed just prior to application. Dye studies and flow evaluations done prior to application will better reflect the characteristics of the

column likely to be experienced at the time of herbicide application. This strategy is expected to result in widespread kill of Eurasian watermilfoil within the treatment area. Because triclopyr is a selective herbicide, it will not result in the loss of many other submerged plants, including the native species.

Several small patches of Eurasian watermilfoil are likely to remain within the control zones after the first year of triclopyr treatment. A few options are available for dealing with these remaining plants. Acknowledging that the goal of this treatment strategy is suppression, not eradication, one approach is simply to leave the remaining patches untreated. However, hand-pulling from boats, shore, or by divers; and/or small scale applications of herbicide to these patches may enhance the benefits of the first year's treatment, and increase the time until another full-scale treatment is needed.

While there are no timing restrictions to the use of triclopyr, it may be subject to irrigation restrictions. Water treated with triclopyr cannot be used for irrigation for 120 days or until concentrations are down to 1.0 ppb. However there are ways to apply this product that will mitigate the need for restrictions on irrigation use. Possibilities considered are shielding the water intakes with physical barriers or using setbacks established for application rates of Triclopyr. (SEE APPENDIX A, CHELAN COUNTY NOXIOUS WEED BOARD EURASIAN MILFOIL MANAGEMENT PROJECT – POTABLE WATER SETBACKS FOR 65 ACRE TREATMENT MAP)
We do recommend monitoring of herbicide concentrations during the first applications to further insure that irrigation limits are easily met. The monitoring sites with be determined by the flow and dye test outcomes. While there are no water take outs for irrigation in the project area, the effects on irrigation water were considered because the results of this project will be important input for other projects on the Columbia River where irrigation water may be an issue.

Implementation of this plan will require annual surveys of the treatment areas. The purpose of the surveys will be to map the extent of re-colonization of milfoil, and other plants, as well as to search for possible new invasive plants. The survey, which could be performed from the water surface, would allow collection of GPS points and polygons to document the plant community.

Herbicide Use Considerations

The herbicide plan specified in the preferred treatment scenario was selected based on its low- toxicity and negligible effect on aquatic species, particularly salmon. A comparison is available showing the relative toxicity of a number of commonly used herbicides, including the formulation discussed under the preferred treatment scenario**.** **(**SEE APPENDIX B, TABLE B-1).

Implications Resulting from Fish Species Migratory Periods

When milfoil control by herbicide use is considered for waters with listed/sensitive fish species the most conservative approach to minimizing effects to fish is to apply herbicides when the fish species of concern are least likely to be present in the treatment area. The mid-Columbia River near the Entiat River is potentially occupied by migrating populations of spring-run Chinook, summer/fall Chinook and Upper Columbia River summer steelhead, bull trout, and Pacific lamprey from late summer through July of the following year, as they migrate up the Entiat River to spawn, or continue their respective migrations further north in the mid-Columbia River.

There is a very brief period of time from mid to late summer when listed/sensitive species are least likely to be present in the mid- Columbia River. Herbicide exposure of Spring-run Chinook is perhaps of least concern because timing of the migration does not coincide with optimal timing for effective herbicide treatment of milfoil. Furthermore, Chinook do not return to the Columbia River after spawning, and out migrating juveniles typically emigrate to salt water in the spring. Bull trout, however, are believed to migrate up the Entiat River to spawn in mid-late August, and then to return to the Columbia River post-spawn to forage. Bull trout remain in the Columbia River and often over-winter there.

While Little et al. (Little, Calfee, & Puglis, 2012) observed bull trout to be quite tolerant of herbicide exposures, the toxicity studies were conducted on early life-stage and older juvenile fish, and no data are available on potential effects to adults in post-spawn condition that are aggressively foraging to regain energy. In general, the most conservative approach for protection of bull trout would be to attempt to time herbicide application during the period when bull trout are spawning up the Entiat River, but prior to their migration back to the Columbia River. Protection of bull trout through this strategy assumes that herbicides would dissipate and degrade rapidly enough so as not to persist in significant concentrations once bull trout returned to the Columbia River.

This anticipated "dissipation and degradation effect" may also assist in limiting effects to the aforementioned salmon and steelhead, and Pacific lamprey anticipated to be present during project implementation. During this period, anticipated to be early-mid August to September, temperatures in the mid-Columbia River will also be elevated, encouraging fish species to seek cooler tributary waters and further reducing the likelihood of bull trout presence in the mid-Columbia River. The most complex migration patterns appear to be those of steelhead. Steelhead are believed to migrate to natal tributaries in late summer or early fall, however some fish will remain in the mid-Columbia River until the following spring before entering tributaries. This pattern makes it likely that steelhead may also be present in the mid-Columbia River near the Entiat River throughout the fall and winter. It may, however, be possible to apply herbicides in the Columbia River while avoiding steelhead migration if the application occurs in the early-mid August to September timeframe, which may reasonably coincide with bull trout migration up the Entiat River.

Herbicide Toxicity Evaluation

An evaluation of aquatic toxicity data was conducted as part of project planning in 2012, to evaluate the potential for herbicides to cause adverse effects to sensitive species. Two herbicides were evaluated for potential use to treat milfoil in the proposed project area. 2,4-D was evaluated because of its relative effectiveness as an aquatic herbicide, its widespread use for control of milfoil and because it is relatively inexpensive to use. Triclopyr was also evaluated because data have shown that it effectively targets and controls milfoil without widespread effects on non-target native vegetation. Aquatic toxicity data for sensitive fish species were generally available for both herbicides.

2,4-D

As part of their biological opinion in consultation with EPA over issuance of their Pesticides General

Permit, NOAA (National Oceanic and Atmospheric Administration, 2011) evaluated and summarized numerous studies related to 2,4-D toxicity to salmonids and other fish species. They concluded from available data that the 2,4-D ester formulation is most toxic and has highest uptake rate in fish and other aquatic receptors. The recommended application rate of 4.0 mg/L 2,4-D ester formulation applied directly to water exceeded all toxicity endpoints evaluated for salmonids, including survival (based on LC50s, or the concentration that was lethal to 50% of the test population), growth, reproduction, and sublethal effects. This application rate also exceeded all endpoints for salmonid prey (invertebrates) and primary production in salmonid habitat, including vascular plants, which provide habitat value for salmonid hiding and rearing.

The recommended application rate of the amine form of 2,4-D on the other hand did not exceed toxicity endpoints for the fish species tested but did exceed the toxicity endpoint for vascular plants. Therefore NOAA concluded that direct water application of any form of 2,4-D would reduce the biomass of vascular plants in the treatment area (National Oceanic and Atmospheric Administration, 2011). 2,4-D is a selective broadleaf herbicide effective for Eurasian watermilfoil treatment, but potentially toxic to other vascular aquatic broadleaf plants. Other vascular plants present in the proposed project area likely include native plants that are important to primary production of the system, and that provide valuable habitat functions such as cover and juvenile rearing for salmonids and habitat for their invertebrate prey base. Most submersed native plants are monocots and will be unaffected by 2,4-D.

NOAA anticipated mostly sub-lethal effects to salmonids, depending on the chemical formulation used (National Oceanic and Atmospheric Administration, 2011). Sub-lethal effects identified included reduction in energy (reduced overall fitness of the animal) for activities such as reproduction, foraging or migration, or even delayed spawning, which may result in inadequate prey base for fry if they are delayed beyond the time when emergent insects are available. Reduced predator evasion is another concern. Overall, these sub-lethal effects have the potential to reduce survival. In the case of listed species, viable populations can be very limited and in fact are limited in the Upper Columbia ESUs/DPSs for Chinook and steelhead, and these sub-lethal effects can have much greater impact than for other fish species with strong viable populations.

Studies conducted by the U.S. Geological Survey (Little, Calfee, & Puglis, 2012) demonstrated relative tolerance by bull trout and rainbow trout to 2,4-D (Weedar 64) which is the less toxic 2,4-D amine formulation. The LC50 was reported at 279 mg/L although abnormal behavior was observed as low as 130 mg/L. USGS exposed juvenile fish at 52, 114 and 212 days post-hatch, and observed that sensitivity did not appear to change with age of fish. This study did not evaluate sensitivity of salmon or steelhead nor did it evaluate the sensitivity of adult post-spawn bull trout.

Triclopyr

Wan et al. (Wan, Moul, & Watts, 1987) evaluated the acute toxicity of four different formulations of triclopyr, and two degradation products, to juvenile Pacific salmonids (including Chinook salmon and rainbow trout). They reported that the triethylamine formulation (Garlon 3A in this study) was the least toxic at LC50s of 275-472 mg/L over the duration of the 96-hour exposures. By comparison, the ester

formulations were much more toxic with LC50s 300-400 times lower than the triethylamine. The degradation products pyridine and pyridinol were also found to be significantly more toxic than the triethylamine, with LC50s in the range of 2.1-4.6 mg/L and 1.5-2.1 mg/L respectively.

This pilot project proposes to use the Rennovate (triethylamine) formulation of triclopyr. In acute toxicity tests, EPA found rainbow trout and salmon species to be similarly sensitive to triclopyr as the triethylamine salt formulation Rennovate 3(LC50s for both in the range of 82-182 mg/L). Likewise, Little et al. (Little, Calfee, & Puglis, 2012) calculated LC50s of 183 mg/L for bull trout and 200 mg/L for rainbow trout (salmon were not tested). It should be noted that abnormalities in fish were observed at 62-74 mg/L in this study, however, this concentration is still well above the recommended application rates for Rennovate 3 (2.5 mg/L in freshwater lakes). Although NOAA (National Oceanic and Atmospheric Administration, 2011) evaluated primarily the ester formulation for terrestrial applications in their biological opinion, they did provide toxicity endpoint data on the triethylamine formulation in appendices. They reported an LC50 of 79.2 mg/L for rainbow trout, a lethal effect concentration of 346 mg/L for the freshwater invertebrate *daphnia magna*, and a lowest observable effect concentration of 46.2 mg/L for the same invertebrate. These data suggest that triclopyr, in the triethylamine formulation is unlikely to cause significant effects to the salmonid prey base if used according to recommended application rates. The target-specific mode of action of triclopyr also indicates that significant degradation of native vascular plants in salmonid habitat is also unlikely as a result of triclopyr application. Triclopyr is a selective broadleaf herbicide effective for Eurasian watermilfoil treatment but potentially toxic to other vascular aquatic broadleaf plants. Other vascular plants present in the proposed project area likely include native plants that are important to primary production of the system, and that provide valuable habitat functions such as cover and juvenile rearing for salmonids and habitat for their invertebrate prey base. Most submersed native plants are monocots and will be unaffected by triclopyr.

Herbicide Selection

The Department of Ecology Herbicide Risk Assessment (Ecology, 2001) concluded 2,4-D DMA will not affect fish or free-swimming invertebrate biota acutely or chronically when applied at typical use rates of 1.36 to 4.8 mg a.i./L. However, more sensitive species of benthic invertebrates like glass shrimp may be affected by 2,4-D DMA, but 80 and 90% of the benthic species should be safe when exposed to 2,4-D DMA acutely or chronically at rates recommended in the label. The risk assessment for triclopyr (Ecology, 2001) also concluded triclopyr will have no significant acute or chronic impact on fish or freshwater invertebrates when rates recommended on the label are used. Field studies support the risk assessment. Acute exposure of fish to triclopyr TEA in the field does not appear to adversely impact survival. Acute and chronic exposure of freshwater invertebrates to triclopyr in the field does not appear to impact numbers, diversity or dominant species. While Little et al. (Little, Calfee, & Puglis, 2012) found bull trout to be relatively tolerant to 2,4-D, NOAA (National Oceanic and Atmospheric Administration, 2011) determined that 2,4-D would likely cause adverse effects to salmon and steelhead,

to vascular plants that provide habitat and to the prey base of these fish. The conclusion of the NOAA biological opinion from 2011 (National Oceanic and Atmospheric Administration, 2011) states that ”pesticide products containing triclopyr BEE, diuron, linuron, captan, and chlorothalonil are not likely to jeopardize the continuing existence of any listed Pacific salmonids. NMFS (NationalOceanic Atmospheric Administration National Marine Fisheries Service) has concluded that 2,4-D is likely to jeopardize the continuing existence of 28 listed Pacific salmonids. NMFS also concludes that the effects of products ontaining triclopyr BEE, linuron, and captan are not likely to destroy or adversely modify designated critical habitat for listed Pacific salmonids as described in the attached opinion. Finally NMFS concludes that the effects of products containing 2,4-D, diuron, and chlorothalonil are likely to destroy or adversely modify designated habitat for some listed Pacific salmonids as described in the attached Opinion” . Based on a consideration of both the Department of Ecology Risk Assessments and the NOAA Biological Opinion the planning team chose triclopyr. This decision mitigates any concerns for threatened and endangered fish species held by the US Fish and Wildlife representatives on the planning team, based on the NOAA conclusions. Because of these factors 2,4-D is not recommended for use in this pilot project.

Based on this evaluation, triclopyr is the least likely to cause adverse effects to the fish species of concern, their habitat and their prey base in this proposed project area, due to its lower toxicity and target (milfoil) specific mode of action. It should be noted that this evaluation considered primarily acute toxicity data based on an LC50 endpoint (as a method of directly comparing species sensitivity and chemical toxicity between herbicides) although other observed responses were also considered during review of the data. LC50 represents 50% mortality of a test population, which is not an appropriate endpoint when sensitive and listed fish species are concerned. Toxicity endpoints that represent lowest observed effect levels, or no observed effect levels should be considered when protection of listed and sensitive species is the objective. Therefore a more in-depth review of behavioral and other chronic endpoints associated with triclopyr should be undertaken prior to conducting the pilot project. The NOAA appendices data would provide useful information in evaluating potential chronic effects to salmonids, their prey base and their habitat (National Oceanic and Atmospheric Administration, 2011). This will establish a “gradient” of triclopyr concentrations that may be considered for various locations within the project area, since fish may be more likely to occupy some habitat areas as opposed to areas with less desirable habitat features. Evaluation of water column concentrations of triclopyr degradation products throughout the pilot project treatment phase is also advisable, given the toxicity data provided by Wan et al. for pyridine and pyridinol (Wan, Moul, & Watts, 1987).

Sensitive Species Assessment

The Washington State Department of Natural Resources Natural Heritage Program database does not contain any records of rare plants or high quality native ecosystems in the project area (Washington Natural Heritage Program, 2012). (SEE APPENDIX C).

The presence of sensitive fish species in the Columbia River was given the utmost consideration during the planning and treatment scenario development (SEE RECOMMENDED CONTROL PLAN SECTION ABOVE, AND HERBICIDE TOXICITY INFORMATION INCLUDED IN APPENDIX B). All treatments with a potential deleterious effect on salmon were eliminated from consideration. The proposed treatment scenario would have no anticipated negative effects on sensitive species in the Columbia River. Working with the US Fish and Wildlife Service, the window of opportunity for treatment was found to be July 15 to August 15, following satisfactory results from flow studies.

The re-colonization of the treatment area in the Columbia River by native aquatic plants is being encouraged by this plan. The submerged species targeted for control (Eurasian watermilfoil) reproduces primarily by vegetative shoots and fragmentation. Native plants maintain a long-lived seed bank that will sprout if suitable growth conditions are present. The removal of the suppressive growth of invasive submerged plants will enhance growth conditions for native plants.

Plan Elements, Costs, and Funding

Table 4 below details the plan elements of the IAVMP for the Columbia River at Entiat with the costs associated with each element. Funding for this project will come from a variety of sources. Chelan County Noxious Weed Board plans to apply for an Aquatic Weed Control grant from the Department of Ecology to help fund the implementation of the project.

Table 4. Estimated cost for the Columbia River IAVMP.

Plan Elements	*Cost per acre or per day*	*Total Cost*
*Deep pool areas 11-16 ft	$1250 (57 acres)	$71,250
*Shallow pool areas to 10 ft	$750 (12 acres)	$ 9,000
Water sampling	$95 (3 days)	$ 285
Posting	$20 (3 days)	$ 60
		$80,595 TOTAL
Grant request @ 75%		$60,446
Matching @25%		$20,149
*Includes application and materials and posting		

Public Involvement

Two public meetings have been held in Entiat. The first was a City Council meeting where a letter of support for the project was requested (Appendix D). The second meeting was an open public planning meeting at the City Council chambers in Entiat. We have also presented two public programs to the 100th Meridian Group and the Washington State Lake Protection Association meeting held in

Wenatchee, WA. One radio presentation was also made on a radio station in the local area of the project.

The public will continue to be kept informed of the implementation of this IAVMP. Public notifications before and during treatments will be posted and widely distributed. Results of water quality and plant survey monitoring (see discussion in following section) will be shared with the public and local agencies, as will any modifications to the IAVMP that result from the data collected during monitoring.

Implementation and Evaluation

The following is a step-by-step approach to implementation of this plan.

Step 1: Set up an IAVMP Advisory Committee

To oversee the implementation of the Control Plan, and to be able to adapt the control plan to changing conditions, the planning team will continue have input on control methods, monitoring effectiveness of control methods, and modifying control methods in response to monitoring results. Each year for three years the IAVMP committee would, at a minimum:

1. Monitor the results of the control treatments
2. Conduct water quality monitoring to track herbicide (following application in concurrence with label requirements
3. Conduct annual plant surveys, supplemented by additional surveys when possible
4. Review results of treatment and current condition of aquatic plants
5. Decide on next steps, including continuation or modification of the initial IAVMP
6. Communicate these results and decisions with regulatory agencies, water management agencies, and other interested parties

Step 2: Apply for a Plan Implementation Grant

Grants for up to $75,000 are available through the Department of Ecology Aquatic Weeds Program for implementation of approved Aquatic Plant Management Plans. Chelan County Noxious Weed board will continue to work with the planning team to apply for these grant funds. This funding would support initial implementation cost while a source of long term funding is being secured.

Step 3: Select Herbicide Applicator

A bid will be prepared for a service contract and an applicator selected for triclopyr application. The bid should include all notification and posting requirements associated with the applications. Herbicide application timing is discussed in the Plant Control Plan section. The Chelan County Noxious Weed Board will apply for the permits for aquatic herbicide application.

Step 4: Conduct Annual Evaluation

Complete a written annual evaluation for three years. The report will be shared with all members of the planning team and other agencies as requested. This should include input from boat surveys, to be conducted at least annually, to provide aquatic plant distribution information. This change over time, compared to the project goals and objectives, will be the criteria for determining the success of the control plan implementation. In addition, water quality testing by the contractor following herbicide application will verify appropriate treatment levels, track herbicide concentrations, and monitor dissolved oxygen before and after treatments to evaluate effects on fish and other aquatic life.

Step 5: Public Education Program

The IAVMP, treatment plan, results of monitoring, and plan modifications developed based on monitoring results should be shared with the City of Entiat, lake users, regulatory agencies and other interested parties. During treatment periods, public notifications will be posted, including on all docks and water access points. This inclusion of the public in information exchanges about the treatment plan will enhance understanding about the rationale for and the low risks associated with the control plan.

Step 6: Evaluate Pilot Project Results for Long-Term Application

The planning team will make a determination based on results of the pilot project as to whether it is a successful and cost effective process for controlling Eurasian watermilfoil in the Columbia River and whether it should be continued and expanded throughout the Columbia River system.

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APPENDIX A

Columbia River Eurasian Milfoil Mapping Project by Aqua Technex, LLC

Columbia River Eurasian Milfoil Mapping Project

Prepared for Chelan County Noxious Weed Control Board

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Introduction

In the 1970's, the invasive aquatic plant *Myriophyllum spicatum*, common name Eurasian Milfoil, was discovered in the Okanagan Chain of Lakes in British Columbia. The BC Ministry of the Environment mobilized an extensive research effort to develop control strategies. They settled on a treatment program to target the approximately 300 acres present in the system. This effort was met with a lawsuit from Green Peace and local anti-pesticide activists. While the Government prevailed in this 18 month court case, the infestation rapidly expanded in this time frame. It was determined that the treatment program was no longer feasible based on the economics and the program shifted to non-chemical control strategies focused on high use areas of the lakes in the system.

As Eurasian Milfoil spreads by fragmentation, and as the Columbia River system is downstream of the Okanogan Lakes Chain connected by the Okanogan River, this noxious weed spread downstream over the years. At this point, Eurasian Milfoil is well established from the mouth of the Okanogan River near Brewster, Washington to the mouth of the Columbia near Astoria, Oregon. These dense beds of invasive plants have colonized much of the littoral area in the river. These weed beds are present in most areas at levels that alter water quality parameters critical to salmonids (Dissolved oxygen, temperature and pH). They also are a burden on hydro-power production facilities and impact recreational uses on the River.

The Chelan County Noxious Weed Control Board has regulatory responsibility to manage weeds on the state noxious weed list. Eurasian Milfoil is a Class B designate within Chelan County, the control of this species is required and landowners with lands impacted by the plant have a duty to manage and control this weed because of the threat it poses to water resources and aquatic habitat.

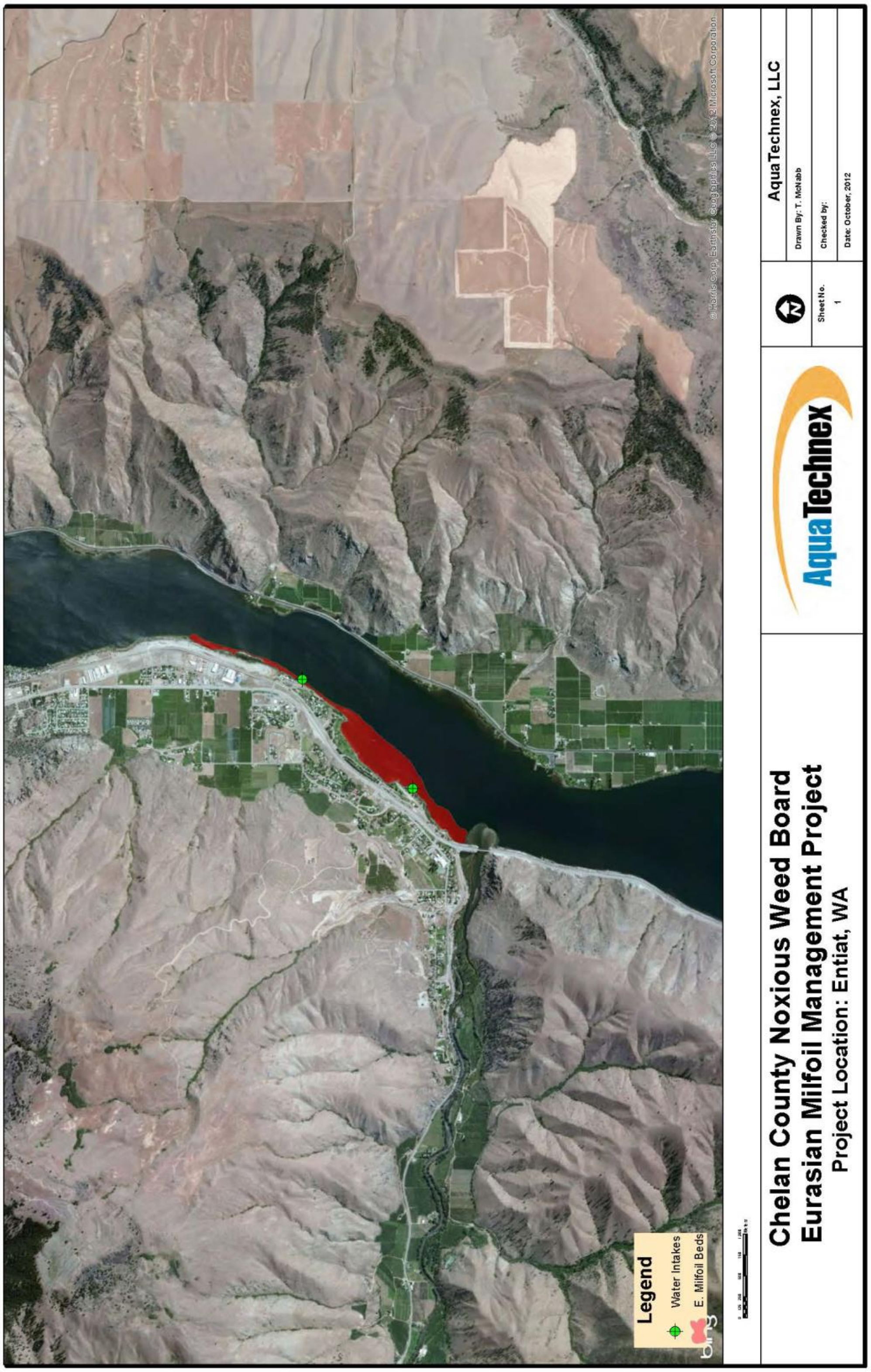
Recognizing the threat posed by this noxious aquatic weed and the Class B designate status of Eurasian Milfoil in County waters including portions of the Columbia River, the Board has taken on the mission of developing a control program. This has included developing a Memorandum of Understanding with the various agencies responsible for management of the Columbia River. It has also included applying for and receiving a grant from the Washington Department of Ecology to begin to develop management strategies that will work in the reservoirs of the Columbia River to target this weed.

Aquatechnex LLC, teamed with the US Army Corps of Engineers Aquatic Plant Control Research Program, has been selected to assist in the development of this control program.

Methods

The first phase of this project will focus on demonstrating aquatic plant management technologies and monitoring results on the Columbia River at the town or Entiat. The steps that are required to generate a treatment protocol and prescription are:

- Identify the boundaries of the potential treatment areas
- Characterize the composition of the aquatic plant communities present
- Map the extent of these plant beds


Legend
Water Intakes
E. Milfoil Beds
Chelan County Noxious Weed Board
Eurasian Milfoil Management Project
Project Location: Entiat, WA
AquaTechnex, LLC
Drawn By: T. McNabb
Checked by:
Date: October, 2012
Sheet No.
1

- Characterize water exchange
- Review herbicides that are systemic and selective for Eurasian milfoil
- Develop treatment areas and water volumes present
- Develop budget for treatment demonstration
- Perform treatments based on protocols developed
- Evaluate control achieved
- Develop recommendations for future efforts.

In September of 2012, the Chelan County NWB delineated the area for the survey effort. Approximately two miles of the western shoreline of the Columbia River were selected for this study. The southern edge of the study area is the mouth of the Entiat River and the northern edge of the study area are the two small islands at the north end of the Town of Entiat. The Town of Entiat manages a park and boat ramp facility in a cove along this shoreline with the balance of the shoreline being main channel of the river.

Aquatechnex developed Geographic information System (GIS) project files in ArcGIS 10.1 software. The team also developed a data dictionary for Trimble Submeter GPS data-logging systems for field data collection. The team mobilized to perform the initial two mapping tasks in September of 2012. A LUND mapping vessel equipped with field GIS technology, Trimble Submeter data-loggers and a Biosonics MX Aquatic Habitat Mapping Scientific Echo-sounder.

The first phase of the mapping effort used a point intercept mapping system to develop a grid station across this treatment area. A point intercept mapping system established sampling locations by GPS location across the littoral area to be surveyed. The mapping vessel navigates to each GPS location and notes the species of aquatic plants present. This is performed visually in shallower water where plants are visible. In deeper water a sampling rake is used to collect aquatic plants present at the site. The Trimble Data-logging GPS receiver use then used to record this information. Drop down menus built for the project in the data dictionary are used to map the most prevalent noxious aquatic weed present at the site, the density of that species at that site, secondary noxious weeds present (if any) and the dominant native species present. A point intercept study prior to application allows the mapping team to quantify species present and density at a number of points across the treatment area. Post treatment, these sites can be revisited and using the same sampling protocol will document the changes that have occurred because of any treatment activity.

The second phase of the mapping mission utilized the Biosonics system to collect transect data perpendicular to the shoreline through the treatment area. This system maps a constant stream of data as the boat travels the transect and also attached GPS location data to the points. Water depth, aquatic plant percent cover and aquatic plant height are determined and mapped by this equipment. This provides a pre-treatment assessment of aquatic plant bio-volume that can be used to compare post treatment results with. That supports the point intercept information. The system maps the bathymetry of the site to assist in the calculation of water volume. This system also was used to detect the deep water edge of the aquatic plant beds and map them.

This data was brought back to our mapping center and processed. The Trimble data was downloaded, we performed differential correction to the data file and exported the data to ArcGIS for mapping using Trimble Pathfinder Software.

The data was then analyzed in ArcGIS and maps were created to characterize the site and exported for inclusion in the report.

Results

A number of maps accompany this report.

The first map shows the location of this project site. The western shoreline of the Columbia River adjacent to the Town of Entiat is the location of the proposed study area. The study area runs from the mouth of the Entiat River north to the small islands north of the Town's water intake location.

The second map shows the distribution and density of noxious aquatic weed growth present at point intercept sampling locations. The two aquatic weed species found that are on the state noxious weed list were Eurasian Milfoil and Curly Leaf Pondweed (a Class C Noxious Weed). There were also native aquatic plants present throughout the system.

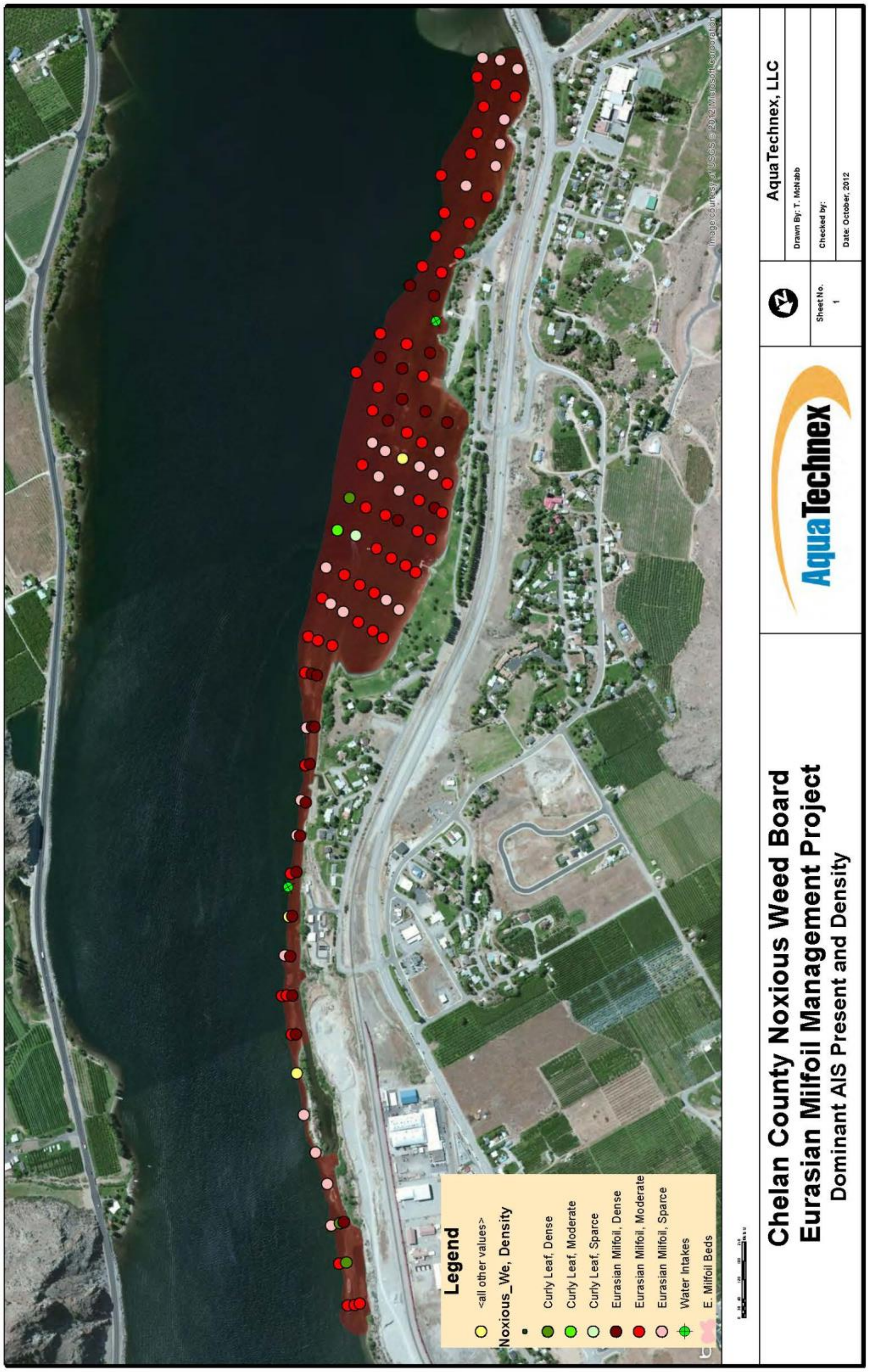
The plant coverage point intercept map shows the most dominant noxious weed species present and the density rating on a scale of sparse, moderate or dense. The map shows that the most dominant noxious weed present throughout the study area was Eurasian Milfoil. It should be noted that Curly Leaf Pondweed was also present at a number of these locations as well as a secondary species. A smaller number of points show locations where Curly Leaf Pondweed was more dominant than Eurasian Milfoil.

If treatments are performed targeting Eurasian Milfoil, resampling these points post treatment will provide a good measure of the efficacy of the application.

The Extent of Coverage map shows the shape and boundary of the aquatic weed beds within the study area. This area measures 69.10 acres in total. The northern portion of this area is a fairly narrow band as the bathymetry in this area shows a very rapid drop off to waters too deep to support aquatic plant growth. As one moves south and into the cove area near the Town Park, the water depths shallow considerably and the aquatic plant bed moves quite a bit further off shore.

The last map shows the location of two water intakes that will have an impact potentially on any treatment performed. Aquatic herbicides have restrictions on the herbicide label that protect potable water supplies as well as irrigated crops using water from in or near the treatment areas. The Potable Water Setback map shows required setback distances established on the herbicide label for Renovate OTF, one of the potential products that would be used to selectively target Eurasian Milfoil. The setback distance is smaller for lower application rates on the label and extends further from the intake as the herbicide rate used goes up.

The Town water supply or potable intake is the northern most of the two intakes mapped here and of concern. The southern intake we believe is for the irrigation district and may not have a potable water



Legend
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Noxious_We, Density
Curly Leaf, Dense
Curly Leaf, Moderate
Curly Leaf, Sparce
Eurasian Milfoil, Dense
Eurasian Milfoil, Moderate
Eurasian Milfoil, Sparce
Water Intakes
E. Milfoil Beds
Chelan County Noxious Weed Board
Eurasian Milfoil Management Project
Dominant AIS Present and Density
AquaTechnex
AquaTechnex, LLC
Drawn By: T. McNabb
Checked by:
Date: October, 2012
Sheet No.
1

Chelan County Noxious Weed Board
Eurasian Milfoil Management Project
Extent of Eurasian Milfoil Beds in Project Area

AquaTechnex

Sheet No. 1

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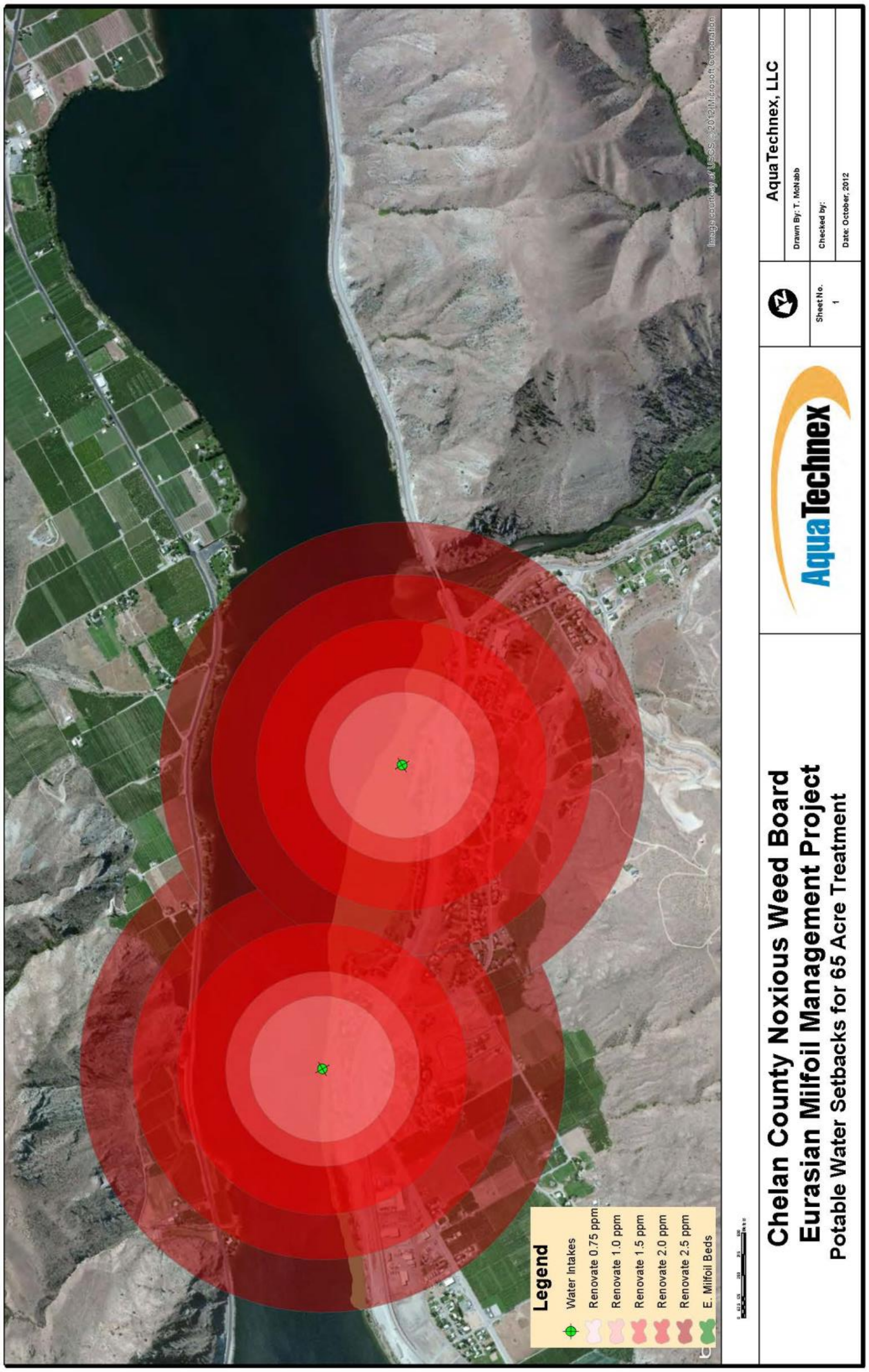
Drawn By: T. McNabb
Checked by:
Date: October, 2012


Chelan County Noxious Weed Board
Eurasian Milfoil Management Project
Potable Water Setbacks for 65 Acre Treatment
Legend
Water Intakes
Renovate 0.75 ppm
Renovate 1.0 ppm
Renovate 1.5 ppm
Renovate 2.0 ppm
Renovate 2.5 ppm
E. Milfoil Beds
AquaTechnex
AquaTechnex, LLC
Drawn By: T. McNabb
Checked by:
Date: October, 2012
Sheet No.
1
Image courtesy of USGS © 2012 Microsoft Corporation

use (there are also irrigation restrictions on these labels). If there is no potable water use at the southern intake mapped, the setback rings mapped would not apply.

At higher rates in this example, this map shows that the majority of the treatment area is inside the setback distance. As such, this herbicide could not be used at those rates unless the potable water intake is not used until water sampling shows that herbicide levels have dropped below the potable water tolerance level.

Recommendations

1. The water exchange study should be performed next summer just prior to the proposed herbicide application. Rhodamine WT dye will be injected into select portions of the treatment area using conventional aquatic herbicide application equipment. This dye can be applied at a known rate and monitored using a flurometer that measures dye levels. By setting sampling stations and using a sampling hose system to obtain water samples from various depths in the water column, concentration exposure times can be determined and used to develop a treatment recommendation as well as select a herbicide that will function well in this treatment situation. As there are two basic conditions present, a fairly well protected cove area where herbicides are expected to have a higher residence time and more exposed narrow bands of weeds where herbicide residence time could be expected to be shorter. As such, a minimum of two study sites should be established, one in each situation. Care should also be taken that the upstream study site does not contribute dye to the downstream location.
2. The Noxious Weed Board is planning on completing and Integrated Aquatic Vegetation Management Plan (IAVMP) this fall and submit a grant application to the Department of Ecology to fund treatments at this site, these maps should be used as appropriate within that document. The one map that may still need to be created is the Beneficial Use Map that is generally required to be present within these plans.
3. With respect to the budget request for treatment, a decision should be made on the extent of the treatment that will be performed here. The costs of application are a function of the herbicide selected, the water volume within the treatment sites and the amount of herbicide then required. If the entire area mapped is targeted for control, then the application will target 69.10 acres. The average depths in the cove area are 6 to 8 feet. The average depths in the more narrow shoreline bands are closer to 11 to 13 feet.
4. There are a number of systemic herbicides available that are selective for Eurasian Milfoil. A number of studies have shown that granular herbicide delivery systems provide superior contact exposure times in moving water situations than liquid formulations that are much more subject to dilution and movement with the current. Sonar Aquatic Herbicide works extremely well against this noxious weed when extended contact exposure time can be maintained. It is probable that this is not the case at this site and Sonar will probably not have a good fit. Renovate OTF is a granular formulation of Triclopyr herbicide on a controlled release pellet. This product has excellent activity against Eurasian Milfoil. It is also systemic and selective for milfoil. Renovate MAX G is a combination pellet of Triclopyr and 2,4-D herbicides. This combination is also effective, systemic and selective. Sculpin is a granular formulation of 2,4-D herbicide and is

the amine formulation that can be used in salmonids bearing waters. Costs per acre are a function of the application rate and water depth.

5. A permit must be secured for the herbicide application. The Department of Ecology manages the NPDES permit to perform this work. Applicators are required to get one permit (with associated fees) for each treatment site. County Noxious Weed Boards may obtain one permit for a number of sites in the County. A Discharge Management Plan is also required for new permit applications, but a IAVMP if developed will meet that requirement.

APPENDIX B

Herbicide Information

Toxicity of Aquatic Herbicides

Herbicide	Maximum[1] Allowable Concentration	Toxic Concentration[2] for Trout (Safety Factor)[3]	Toxic Concentration for Water Fleas (Safety Factor)	Toxic volume of water for ducks[4]	Time to Degredation[5]	Potential To Accumulate in Fish and insects
Glyphosate	N/A	38 ppm	780 ppm	N/A	Variable	Very Low
Imazapyr	N/A	>100 ppm	375 ppm	N/A	<20 days	Extremely Low
2,4 D	4 ppm	>80 ppm (20)	235 ppm (60)	250 Liters	35-70 days	Low
Triclopyr	2.5 ppm	120 ppm (45)	1500 (600)	680 Liters	70-140 days	Very Low
Fluridone	0.15 ppm	11.7 ppm (75)	6.5 ppm (45)	>33,333 Liters	100 days	Low
Diquat	0.37 ppm	12.3 ppm (35)	0.75 ppm (2)	1500 Liters	<14 days	Very Low
Endothall	5 ppm	370 (75)	75 ppm (15)	>1,000 Liters	<14 days	Very Low

Note: The summary information on this table was retrieved from EPA, Cornell Extension Toxicology Network, and National Pesticide Information Center factsheets.

1. Most aquatic herbicides are applied at 30-100% of the maximum allowable concentration. For milfoil control, fluridone is typically maintained at 5-10% of the maximum
2. allowable concentration.
2. A toxic concentration of chemical in the water will kill 50% of a test population of animals (trout or water fleas) exposed to the chemical for 48 hours.
3. The Safety factor is the number of times the maximum allowable concentration needed to achieve a toxic dose. For example: 2,4 D at 80ppm, or 20 times the maximum allowable concentration (4ppm) is needed to reach toxic levels for trout.
4. The toxic volume of water is the amount of treated water at the maximum allowable concentration that a duck would need to drink in a dayto accumulate a toxic amount of the chemical in their tissues.
5. All of the herbicides listed here, except for glyphosate which is broken down in the soil by microbes, are degraded by sunlight. The time to degradation is the amount of time needed for the chemical to degrade to a point where it is not detectable in the water, or at a level where it won't harm plants if used for irrigation.

HERRERA ENVIRONMENTAL CONSULTANTS

APPENDIX B

Herbicide Information

Herbicide Information

Triclopyr

What is Triclopyr and how does it work?

Triclopyr is a fast acting systemic herbicide that is selective in controlling dicots (flowering plants that have two seed leaves) such as Eurasian watermilfoil. Other aquatic plants such as coontail, bladderwort, and water lilies are also somewhat susceptible to Triclopyr treatments.

Triclopyr is available in both solid and liquid formulas under a variety of names.

Triclopyr works by mimicking the plant growth hormone auxin. When dicots are exposed to high concentrations of auxin their stems twist and elongate in an uncontrolled fashion which causes the plants to die. Triclopyr is not effective against monocots such as Brazilian elodea, because pathway that is affected by Triclopyr in dicots is different in monocots.

What plants are controlled by Triclopyr?

Aquatic Weeds

alligatorweed	milfoil species	pickerelweed
American lotus	nuphar (spatterdock)	purple loosestrife
American frogbit	parrotfeather*	waterhyacinth
aquatic sodaapple	pennywort	waterlily
Eurasian watermilfoil	phragmities	watershield
		water primrose

Is Triclopyr safe to use?

Triclopyr is thought to be relatively safe for humans and the environment. According to the EPA factsheet, Triclopyr was found to be slightly toxic for birds, and practically non-toxic for mammals, amphibians and freshwater fish and insects. Triclopyr is not known to cause any effects due to chronic exposure, but tests in rats were inconclusive, suggesting that there may be some risk. Triclopyr poses a slightly higher environmental risk because it does not bind to soil particles like many other herbicides so it is more mobile and persistent in soils. However, in the water column it is broken down relatively quickly by sunlight, and testing of wells in areas
where triclopyr was used did not exhibit contamination.

What use or timing restrictions are there?

Triclopyr is not subject to any fishing restriction, or fish timing windows. Swimming is prohibited for 12 hours in the treated areas. Application may not exceed 2.5 ppm for the treatment area in a single season.

Water may not be used for irrigation within 120 days of application or if concentrations are above 1 ppb. As with any aquatic herbicide, proper permits need to be obtained, and triclopyr can only be applied by a Washington state licensed applicator.

How much does Triclopyr cost?

As with any aquatic herbicide there are many factors that can affect the overall application cost. However a reasonable estimate for planning purposes is $600 per acre.

Are there any downsides to using Triclopyr?

Triclopyr is only affective against milfoil and other dicots. If there are other invasive plants in the area, such as Brazilian elodea, that are not affected by Triclopyr, then use of this herbicide can give them the opportunity to invade the area that was occupied by the milfoil. Brazilian elodea is equally problematic, and equally difficult to control, so using Triclopyr as a sole control strategy could potentially trade a milfoil problem for an elodea problem.

Some additional materials on triclopyr:

- National Pesticide Information Center Factsheet
  http://npic.orst.edu/factsheets/triclogen.pdf

- Washington Department of Ecology Aquatic Herbicide Page
  http://www.ecy.wa.gov/programs/wq/plants/management/aqua028. html

- University of Florida Aquatic Plant Management website
  http://plants.ifas.ufl.edu/guide/sup3herb.html

APPENDIX C

Rare Plant and Animal Information

November 5, 2012

Julie Sanderson
Chelan County Noxious Weed Control Board
400 Washington St.
Wenatchee WA 98801

SUBJECT: Natural Heritage Report for Dept. of Ecology grant (T25N R21E S09, 16, 17)

We've searched the Natural Heritage Information System for information on significant natural features in your project area. Currently, we have no records for rare plants or high quality native ecosystems in the vicinity of your project.

The information provided by the Washington Natural Heritage Program is based solely on existing information in the database. In the absence of field inventories, we cannot state whether or not a given site contains high quality ecosystems or rare plant species; there may be significant natural features in your study area of which we are not aware.

The Washington Natural Heritage Program is responsible for information on the states rare plants as well as high quality ecosystems. For information on animal species of concern, please contact Priority Habitats and Species, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia WA 98501-1091, or by phone (360) 902-2543.

For more information on the Natural Heritage Program, please visit our website at http://www.dnr.wa.gov/ResearchScience/Topics/NaturalHeritage/Pages/amp_nh.aspx. Species lists and fact sheets, as well as rare plant survey guidelines are available for download from the site. For the self-service system, please follow the Reference Desk link to Location Search. Please feel free to e-mail us at natural_heritage_program@dnr.wa.gov if you have any questions.

Sincerely,

Jasa Holt, Data Specialist
Washington Natural Heritage Program

Forest Resources & Conservation Division, PO Box 47016, Olympia WA 98504-7016

APPENDIX D

Letters of Support

To: Washington State Department of Ecology
From: Entiat City Council and Mayor
RE: Chelan County Noxious Weed Control Board grant application

Date: September 9, 2011

The City of Entiat resides along the Lake Entiat portion of the Columbia River (also known as the Rocky Reach pool). When the Rocky Reach Hydroelectric Project was implemented, over 50 years ago, the City was flooded and very little was rebuilt. Now, City leaders have achieved support and funding to build a waterfront tourist development. This development will include a transient marina and swimming beach. In addition, the Chelan County PUD is in the process of revitalizing a shoreline park in the City of Entiat and adding an additional boat launch.

Unfortunately, this reach of the Columbia has a significant problem with Eurasian watermilfoil. This invasive species becomes a hazard for boaters, water skiers and swimmers. Currently, the Chelan County PUD uses a cutting device to improve the recreational situation, but cutting the plant only causes it to spread and grow in other places. Even with twice per season cutting, the milfoil continues to be a hindrance to recreational use of this beautiful natural resource. The prevalence of milfoil threatens to minimize the economic development potential of the new marina and boat launch – development that the City's economy desperately needs.

It has come to our attention that the Chelan County Noxious Weed Control Board is working to contain and/or eliminate the milfoil problem in this area. We the Council and Mayor of the City of Entiat fully support the Board's efforts and ask that the Department of Ecology award the grant to provide a much needed service to the residents and visitors of Entiat and Chelan County.

Thank you for your attention to this matter,

Keith W. Vradenburg

Keith Vradenburg, Mayor

P.O. Box 228, 14070 Kinzel Street • Entiat, Washington 98822
Phone: (509) 784-1500 • Fax: (509) 784-1112
Email: city@entiat.org

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
Eastern Washington Field Office
11103 East Montgomery Drive
Spokane Valley, WA 99206

November 23, 2011

Melanie Tyler
Washington State Department of Ecology
Water Quality Program
P.O. Box 47600
Olympia WA 98504-7600

Dear Ms. Tyler:

Subject: Eurasian Watermilfoil Planning Project

The U.S. Fish and Wildlife Service (Service) is sending this letter in support of the Chelan County Noxious Weed Board's (Board's) proposal to develop a Eurasian watermilfoil control plan for the Columbia River near the City of Entiat, WA. The proposed project would implement aquatic invasive species management planning, including an aquatic plant species inventory, a dye study to evaluate flow and potential herbicide dispersion rates, and an evaluation of potential herbicide toxicity to sensitive fish species, along a 2 mile stretch of the Columbia River just upstream of the Entiat River delta.

The Service has specific interest in maintaining high quality aquatic habitat in this area because federally listed fish species, including spring and fall Chinook (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*) and bull trout (*Salvelinus confluentus*) occupy this reach of the Columbia River throughout the year. This reach is within bull trout critical habitat, and bull trout feed near the Entiat River delta in the fall after spawning up in the Entiat River. They are also believed to overwinter in this reach of the Columbia River.

As the Washington State Department of Ecology is well aware, Eurasian watermilfoil is adapted to a wide range of environmental conditions and has proven to be highly competitive in the Columbia Basin. In the process of protecting aquatic habitat, however, it is important to consider the most sensitive receptors that occupy the habitat, in order to maintain a viable aquatic system as a whole. For example, herbicides are commonly used as an effective means of aquatic invasive species control. Recent research on toxicity of herbicides to listed fish species indicates that listed species can be more sensitive to some herbicides than fish species commonly used in laboratory toxicity tests, such as rainbow

TAKE PRIDE IN AMERICA

2/5/2013

To: Mike Mackey

Chelan County Noxious Weed Coordinator

From: Keith Vradenburg

Mayor

Cit of Entiat

Re. City of Entiat's Water System

Mike,

The City of Entiat's Water System does not take water directly from the Columbia River. The CityHas two wells, forty (40) feet from the rivers edge and each well is 140 feet deep. Also, at this Point, the river current is several miles per hour. As far as turning off the pumps, the length of time depends on when this needs to be done and the day of the week. During the summer of 2014, the park will be closed, so the two City wells can be shut off for longer periods of time. 24 to 48 hours of down time will not be a problem.

Keith Vradenburg

Mayor

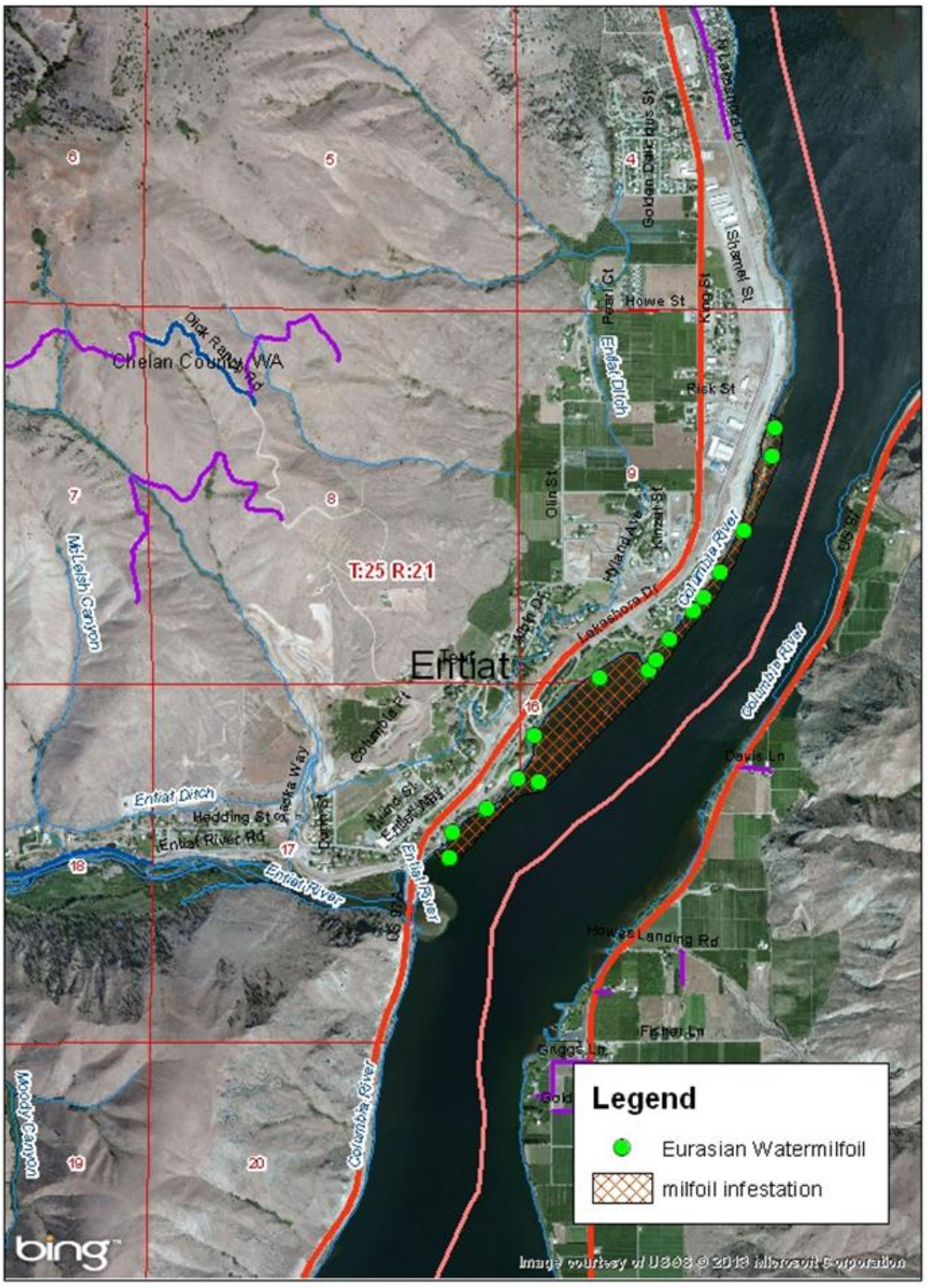
City of Entiat

P.O. Box 228, 14070 Kinsel Street • Entiat, Washington 98822
Phone: (509) 784-1500 • Fax: (509) 784-1112
Email: city@entiat.org

FIGURE 1.

Map of Project Area

Figure 1. Eurasian Watermilfoil Project Area at Entiat on Columbia River



Area = 69 acres Length = 2 miles
North of confluence of Entiat River